Simulation Output Subsystem

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Outline

- definition
- specification
- issues
- requirements
- design
- development
- usage
- status

Definition

The output subsystem collects data from a running microsimulation, stores the data for future use, and manages the subsequent retrieval of the data.

Specification

- The simulation output subsystem will gather the data generated by simulations and provide access to it for other subsystems as soon as the data is received.
- The simulation output will be configurable and several predefined configurations will be provided.
- This subsystem will utilize the database subsystem to support metadata.
- It will support data distribution, data export, and archiving.
- Special provision will be made for dealing with the large amount of data generated by simulations.

Issues

- The CA microsimulation will generate large amounts of data on several computational nodes (CPNs) simultaneously.
- The computer communications network (ethernet, etc.) is required for simulation-related communication between CPNs; any other use of it will slow down the simulation.
- Users will want to specify what data will be collected, and when and where it will be collected.
- Users will want to retrieve only a portion of the complete data set, in order to perform analyses on data of interest.
- Users will want automated support for navigating through data sets.

Data Volume

- Approximately 30-60 bytes of data are needed to describe the state of a vehicle at any given time in the simulation.
- Data can conceivably be collected for each vehicle every time it is moved (currently, once per second).
- In the largest metropolitan areas, it is possible for 1,000,000 vehicles to be moving on the road network simultaneously.
- This means that a four-hour simulation could require 400-800 GB of storage, if all trajectory data is stored.
- *Conclusion:* The output subsystem has to efficiently store large amounts of data; it also must have the capability to *not* store data when it is not necessary to do so.

Requirements

- Data must be stored locally on each computational node, so that communication network traffic is minimized.
- Data must be retrieved globally, so that it can be analyzed anywhere.
- Several retrieval formats must be supported, so that post-processing is flexible.
- The simulation output subsystem must have a general interface, so that it can collect data from any TRANSIMS simulation, not just the current CA-based simulation.

Requirements (continued)

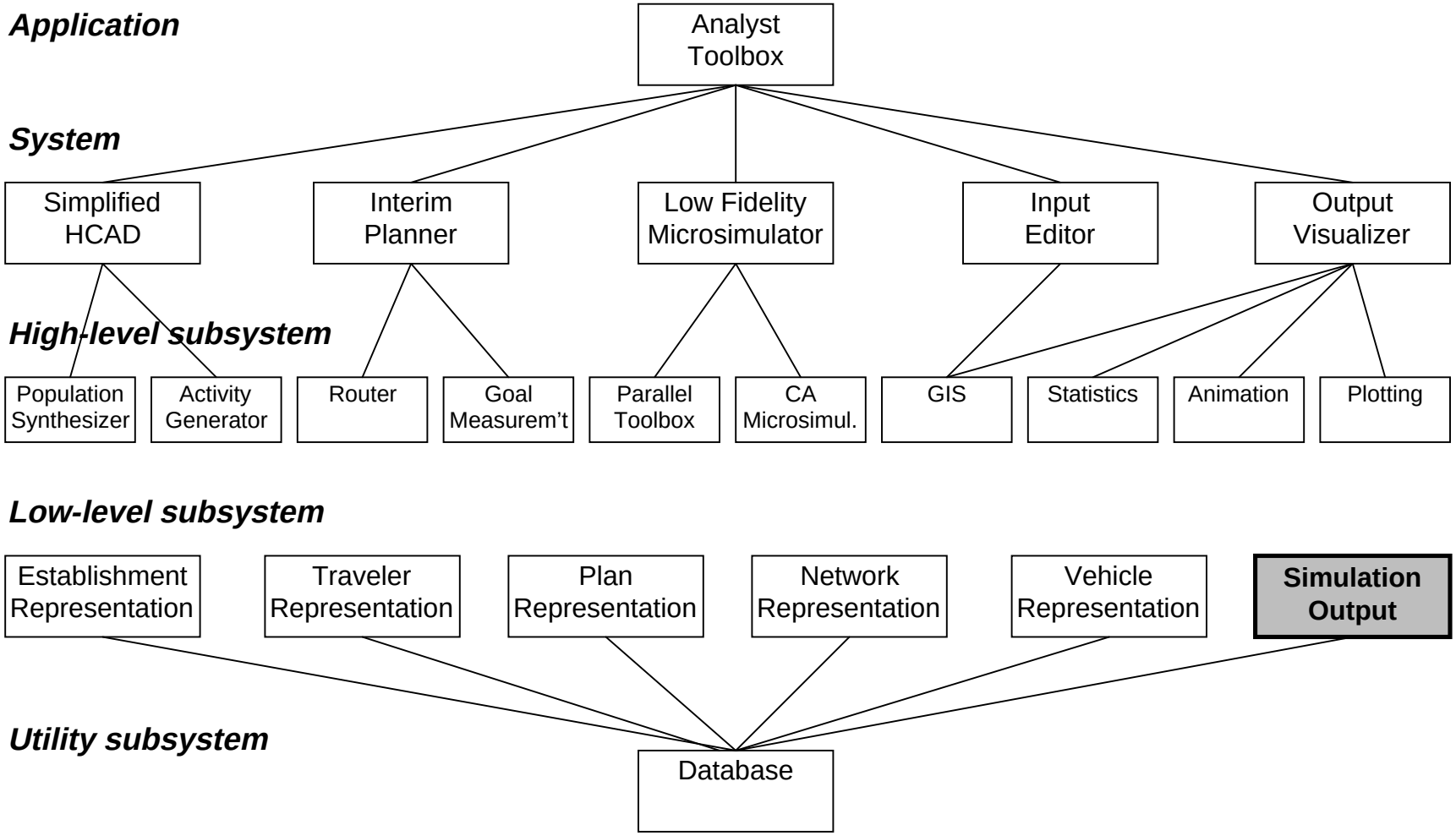
- Both as the data is collected and when it is retrieved, it must be possible to summarized the data:
  - counting
  - averaging
  - accumulating
  - binning
  - statistical functions

  This will reduce storage requirements and access time and minimize data transmission over the communication network.

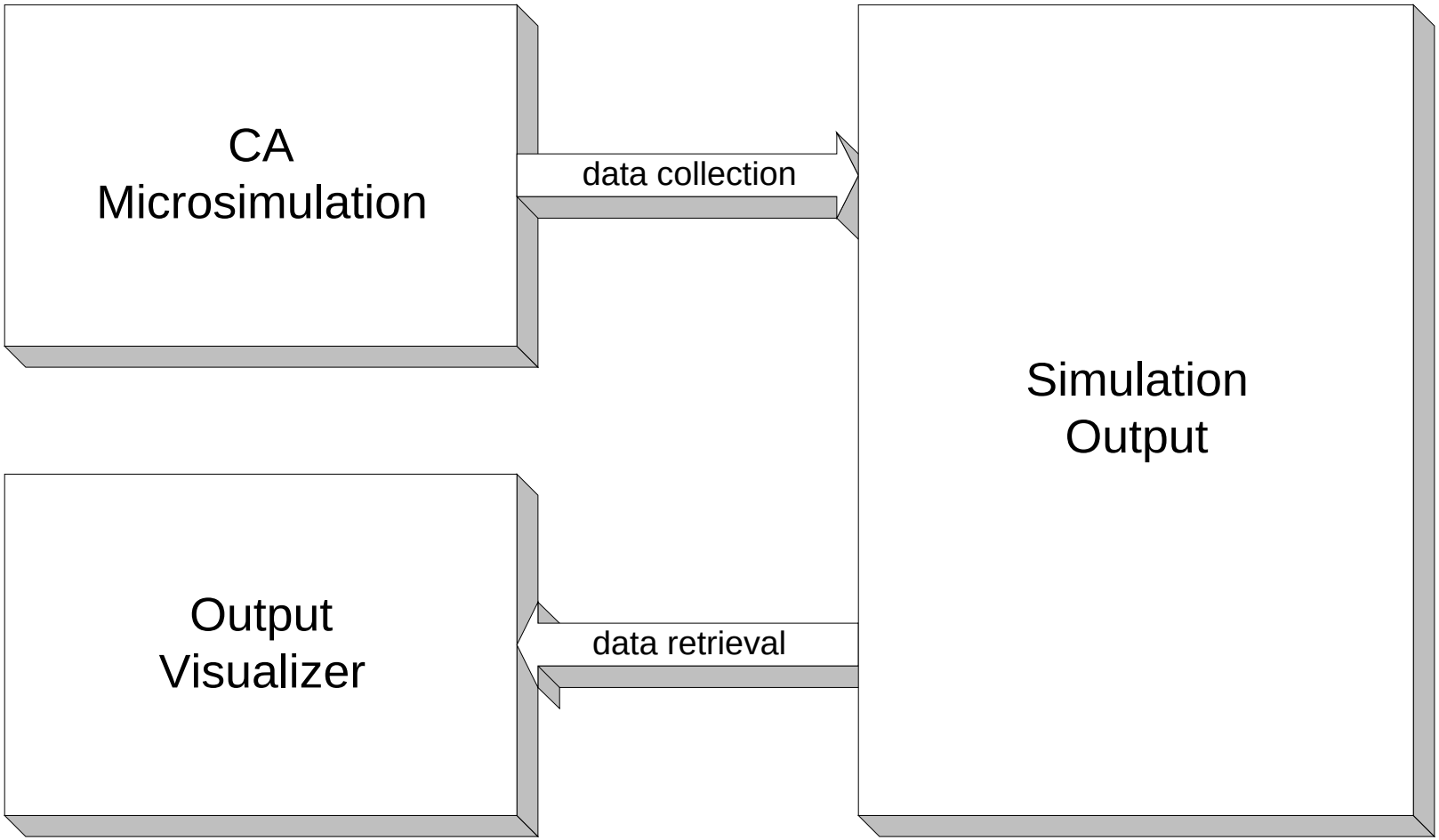
- Metadata for each data set must be available, so that the data set is self-defining.

- The simulation output subsystem must have a “low overhead,” so that it does not unduly slow a running simulation.

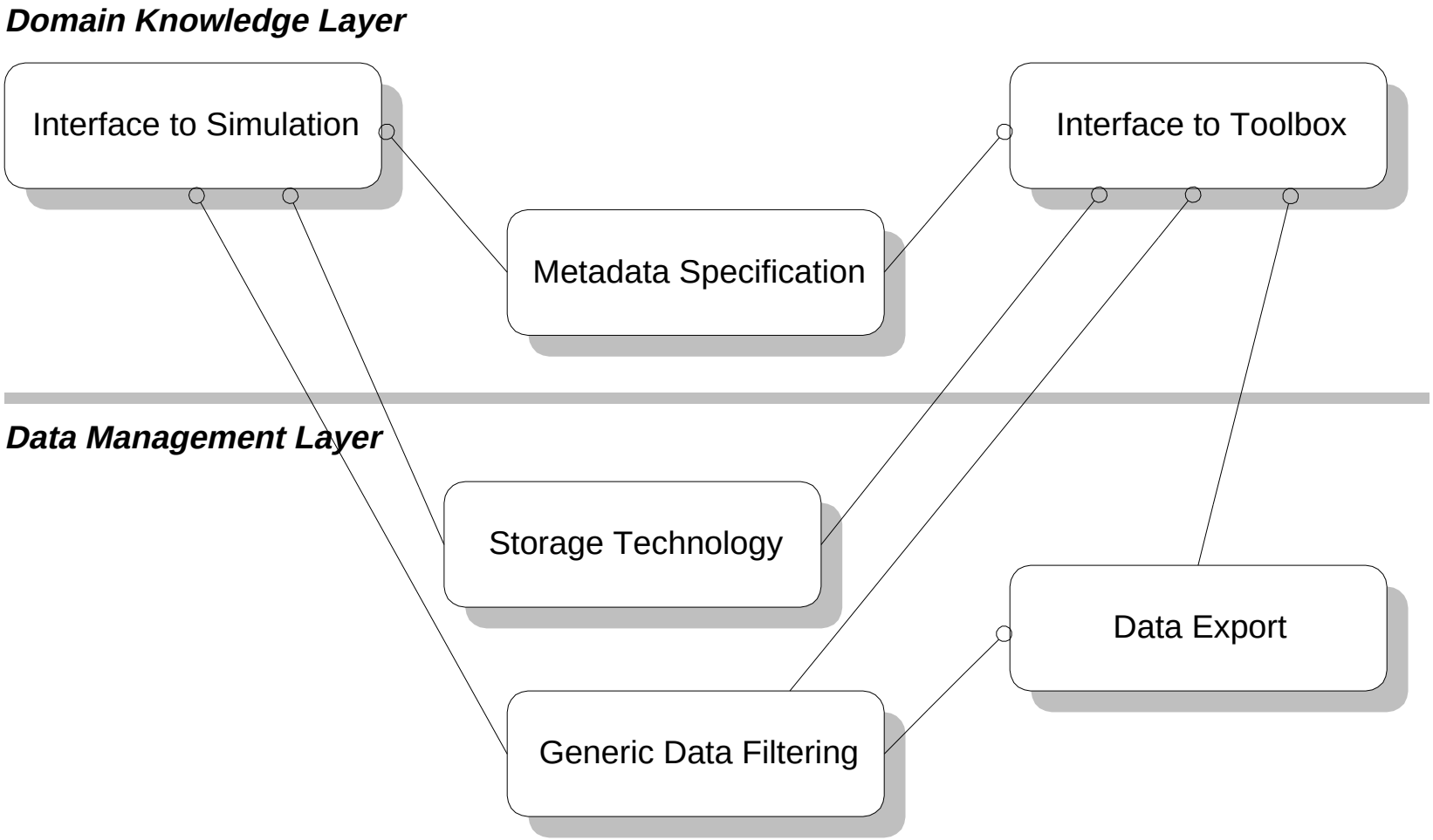
TRANSIMS Software Architecture



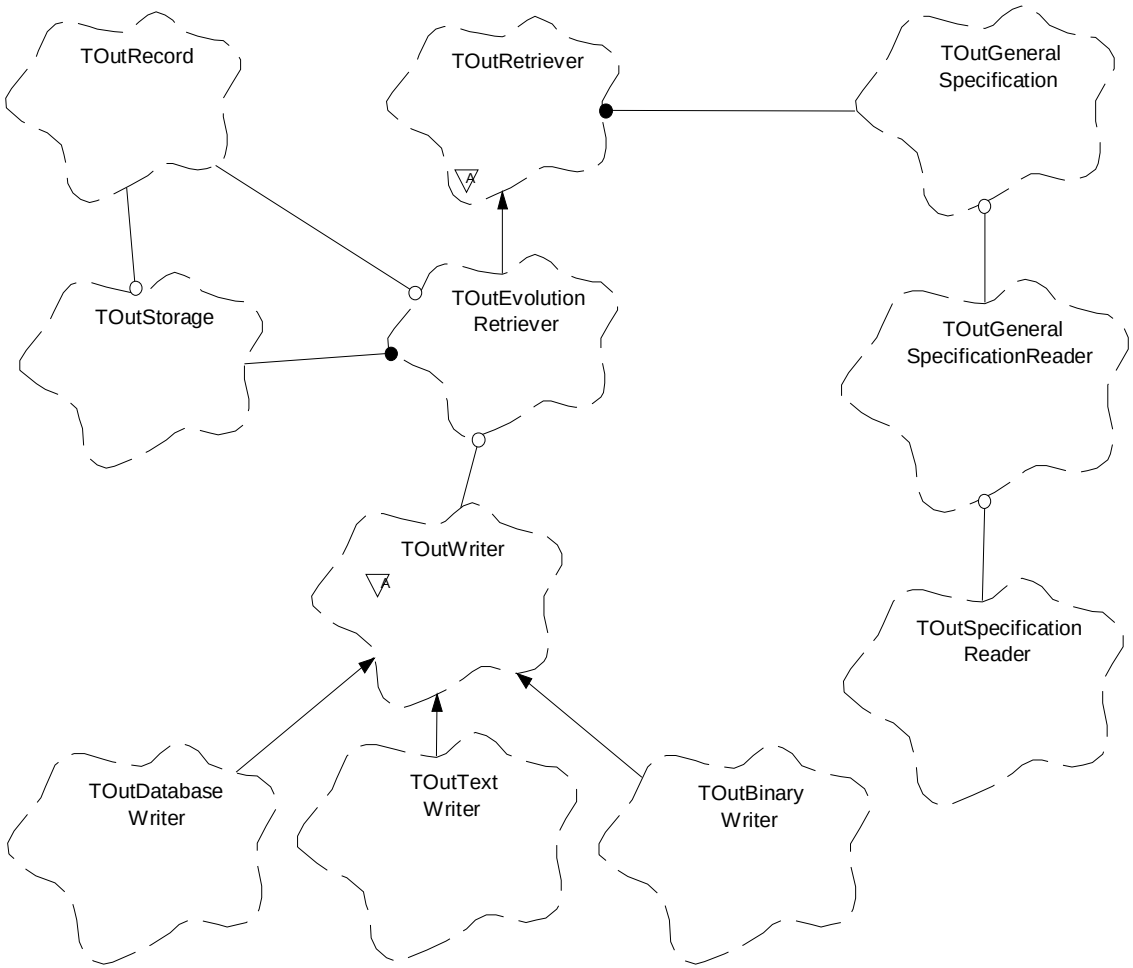
Connections between Subsystems



Internal Structure



Example: Classes Involved in Trajectory Retrieval



Modularity and Reusability

- The simulation output subsystem is not dependent on the components of TRANSIMS that use it:
  - CA microsimulation
  - Analyst toolbox-related components

- The simulation output subsystem is dependent upon only two components of TRANSIMS:
  - Network subsystem
  - Database subsystem

- The simulation output subsystem can be used to collect data from *any* TRANSIMS traffic simulator, not just the current CA-based one.

Iterative Development

The development of the simulation output subsystem has proceeded according to an iterative development process.

√ 0. Architecture

√ 1. Design

√ 2. Basic functionality

3. Enhanced Retrieval and Filtering

4. Summary Data Processing

5. Optimization

Usage

- The user specifies the following before a simulation run:
  - when and where in the traffic network to collect data
  - what data to collect
    - raw data
    - summaries
    - distributions
    - correlations
  - what data to filter out

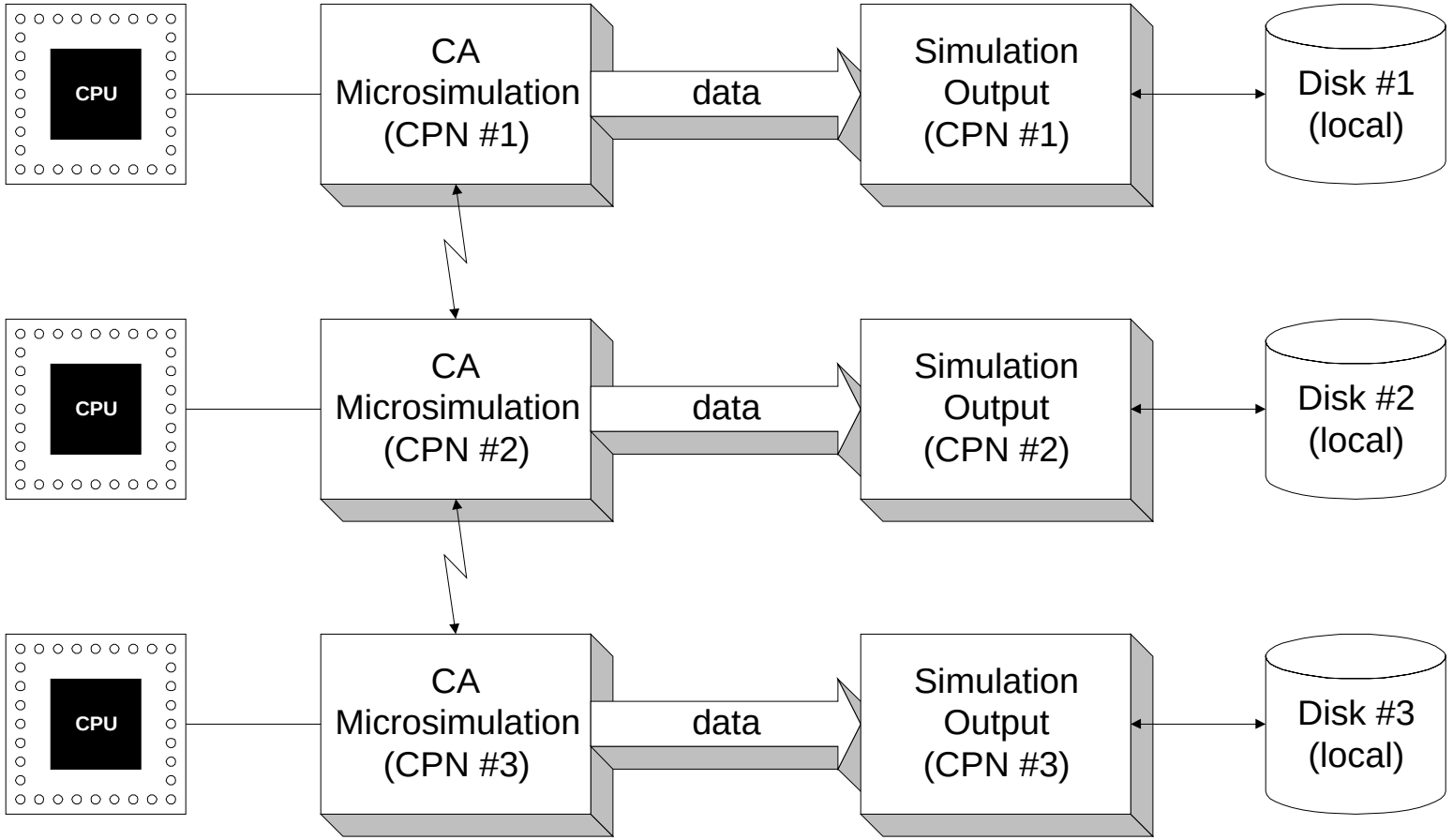
- There are two basic types of data:
  - *Evolution data* is the trajectory information needed for animation, waterfall plots, debugging, etc.
  - *Summary data* is the statistical information needed for fundamental diagrams, measures of effectiveness, etc.

Usage (continued)

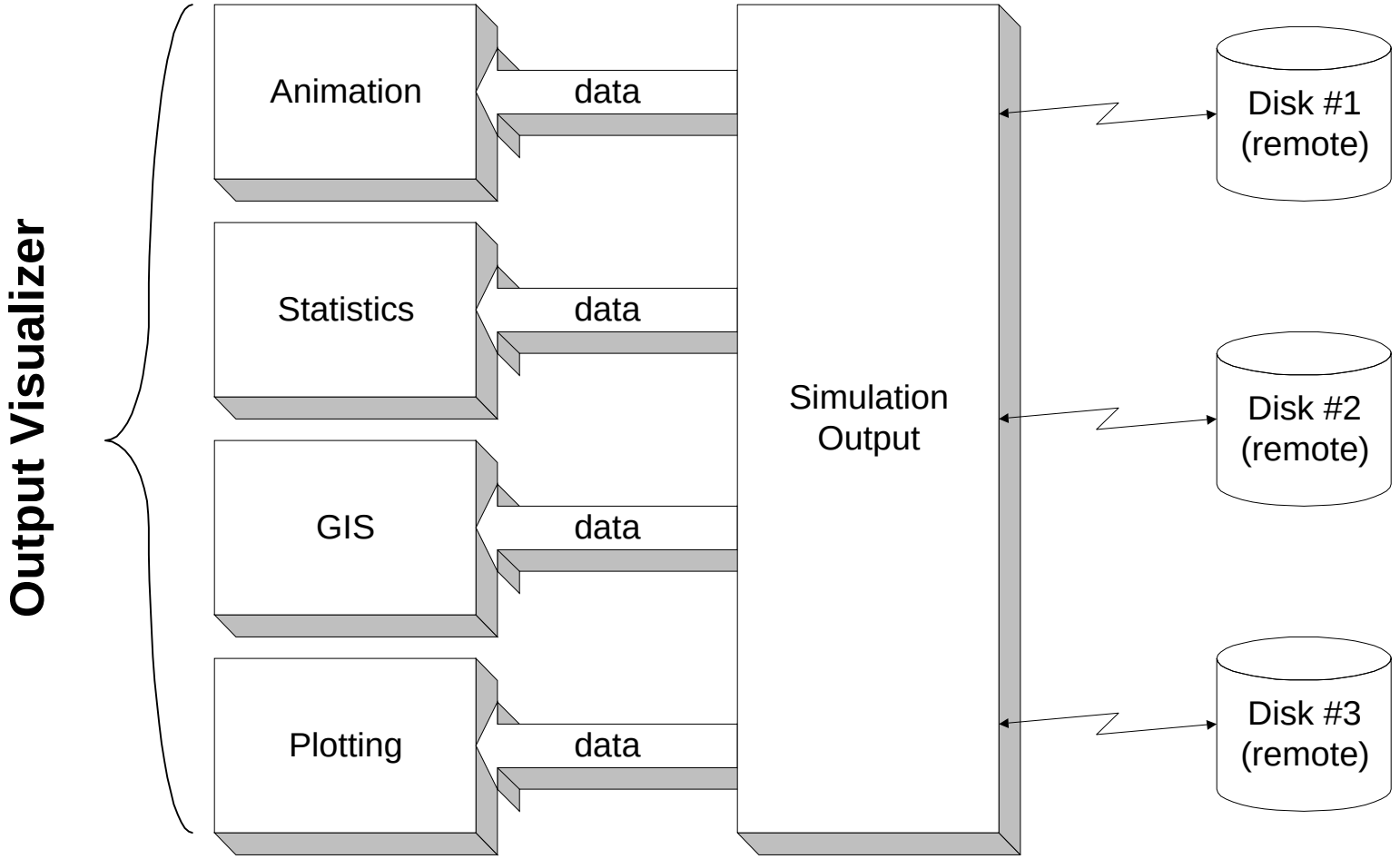
- The user specifies the following when retrieving data from a simulation run:
  - when and where in the traffic network to retrieve data
  - what data to collect
    - raw data
    - summaries
    - distributions
    - correlations
  - what data to filter out

Note that the options for collecting data from a simulation are the same as those for retrieving it from storage.

Data Collection



Data Retrieval



Current Status and Functionality

- Iterations 0, 1, and 2 have been completed. This includes implementation, testing, and documentation.
- The simulation output subsystem has been linked to the CA microsimulation and collects basic “evolution” (i.e., trajectory) data.
- Data is collected locally, so as not to slow down the running simulation, but it is seamlessly accessed from the distributed file system when retrieval occurs.
- Both on collection and retrieval, the data can be filtered by time, frequency in time, node id, and link id.
- Retrieved data is stored in delimited text files (a standard import format for many commercial data analysis products).